DOCUMENT RESUME

ED 087 458 IR 000 202

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TITLE Planning and Controlling Computer-Based Systems Development.
INSTITUTION Florida State Dept. of Education, Tallahassee.
PUB DATE Apr 73
NOTE 18p.; Paper presented at the Association for Educational Data Systems Annual Convention (New Orleans, Louisiana, April 16 through 19, 1973)

EDRS PRICE MF-$0.65 HC-$3.29
DESCRIPTORS *Computer Oriented Programs; *Computer Programs; Data Processing; Information Processing; *Management; *Planning; Program Descriptions; Programing; State Departments of Education; Systems Analysis; *Systems Development
IDENTIFIERS AEDS; Association for Educational Data Systems; Florida Department of Education; IBM Project Control System; PCS; Project Management Procedure

ABSTRACT

A project management procedure used in conjunction with the IBM Program Control System (PCS) is described. Information is given on how the combination is used by the Florida Department of Education to control the cost of data processing projects and to ensure their completion on schedule. The first section of the paper describes the project management procedures, discussing background material, the Information Systems Section of the Department of Education, and needs identified by the Section. Also reviewed are the seven phases of the management procedure: 1) problem analysis; 2) problem definition; 3) systems analysis; 4) systems design; 5) program specifications; 6) programing and implementation; and 7) systems evaluation. The second part of the paper deals with the Project Control System, with emphasis upon network and system concepts. The concluding section of the report describes the application of the project management procedures and the Project Control System to the development of a large computer-based system run by the Florida Department of Education. Topics discussed include the history and development of the computer system. A summary and some conclusions are also presented. (PB)

PLANNING AND CONTROLLING COMPUTER-BASED SYSTEMS DEVELOPMENT

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INTRODUCTION

One of the most discussed, but also one of the most elusive topics in data processing in the past few years is project management or project control. Seminars have been devoted to this topic; it has been discussed at conventions; project management courses have been offered; books have been written about it. Typical observations are, "data processing projects never finish on schedule", and "these projects end up costing at least twice as much as originally planned." These observations are indicative of the two primary purposes of project management which are:

1. Completion of the project within the schedule, and
2. Control of the cost of the project

Indeed these two purposes are interrelated to the extent that our presentation will consider both as one and the same. If a project is completed on schedule, it follows that project development cost is controlled. This will hold true unless extra resources must be applied in order to meet the schedule.

To my knowledge, there is no panacea for good project management. What is advocated here may not be appropriate in every situation, but the Florida Department of Education has developed a technique that has worked. This technique is a well-defined project management procedure coupled with a computer assist from the IBM Project Control System (PCS).

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This presentation will be made in three parts. The first two parts will describe the technique, while the third part will demonstrate the application of the technique to a major computer system development

PROJECT MANAGEMENT PROCEDURES

The Information Systems Section

To understand our project management and control procedures, it is essential to have an understanding of the role of the Information Systems Section and the environment in which it functions. The Florida Department of Education is primarily composed of the following four divisions: Elementary and Secondary Education, Vocational Education, the Community College System, and the University System. The Department also has a significant number of agencies whose function is to support these divisions. The Information Systems Section is one such organization and its primary function is to provide data processing and related services to all other agencies of the Department.

Background

Several years ago our shop was run in a rather "slipshod" fashion. At the time we were, of course, unaware of this. We were never able to meet deadlines; the manpower requirements to maintain and modify poorly designed systems was greatly restricting the number of new systems which could be developed; and inefficient use of the computer was the rule, rather than the exception. We found ourselves turning down projects because we just didn't have time. In reality, we didn't know for certain whether we had time or not, because we were not sure when our current projects would be completed, nor the amount of time future planned projects would require. One of the obvious results of this "firefighting" was that our image was very low. In other words, the general feeling around the Department of Education was that we could not produce.

We came to the realization that something had to be done, but the question was what? We were certainly aware of the steps required to complete our primary task: systems development. Some of these, of course, are problem definition, analysis, design, and programming. But how do we manage this development? Within each of these areas or activities, there are problems. We decided that we must identify these problems if we were going to overcome them.

Needs Identified

After studying the situation, it seemed that all of the problems could be classified into the following twelve needs which had to be satisfied.

1. Management involvement in all phases of development. It was imperative that we get management more involved in the development process.
2. Well-stated objectives. These needed to be written down, understood and agreed upon by all parties involved.
3. Accurate estimate of project cost. We must be able to better project the manhour and computer requirements for every system under development.

4. Checklist to assure that critical phases are not overlooked. Not only will the checklist prevent an inadvertent omission of an activity or item, but it will help to insure an organized and systematic approach to each phase of development.
5. Management understanding and acceptance of lead times and costs. Management must be kept informed of the progress of development. They should never be surprised with extreme overruns in either time or cost.
6. Clear-cut evidence of completed milestones. Everyone involved should be aware when a phase is completed. The activities of a phase should not begin until the preceding phase has been completed.
7. A means for communicating system and programming specifications. It is very difficult to verbally communicate between analyst and programmers. It is even more difficult to effectively communicate between systems personnel and user personnel. Consequently, almost all communications need to be in writing to enhance the effectiveness of communications.
8. Review by experienced personnel. Both managerial and technical personnel need to have an opportunity to review development at various points to insure that the best operational and technical approach is being incorporated.
9. Time for review by many people. Time must be available for all individuals who will be directly involved to become oriented to the new system.
10. Formality and rigor in reaching clear-cut decisions. The administrator needs to know when a decision is required. Management must be the one who makes the decision; this responsibility cannot be abdicated.
11. An elimination of controversy over system deficiencies. Even if the deficiencies can't be eliminated, the controversy can be.
12. A method useful for contract administration.
    a. To overcome misunderstandings between customer and contractor.
    b. To alert both to slippages.
    c. To enable timely action to be taken by both.
    d. To assure management control which otherwise may be lacking.

To this list another consideration should be added: flexibility. We had to control projects without ourselves being controlled. We realized that no fixed procedure could be developed which would handle every situation that could arise. Our staff had to have the capability of exercising judgment upon individual situations.

The Procedure

Having identified our needs, we had to determine how best to satisfy them. We began a search of literature, books, and the approaches used by other installations. Our two best sources were Administering and Controlling the Company Data Processing Function by Leonard I, Krauss (1), and the TRB & S Systems Management Series from Touche, Ross, Bailey, and Smart. Inc. (3)

Now let's look at the Project Management Procedure. As we view this procedure, please keep in mind two important features:

1. The delivery of a paper or a document to the user signals the completion of a phase.
2. The user is involved and must agree to some specification before the next phase is initiated.

The phases which are briefly described below constitute our Project Management Procedure. Each phase is graphically illustrated in Figures 1 through 7.

I. Discussion and Problem Analysis (Figure 1). The results of consultation between staff members of the user's organization and Information Systems is a Requirement Statement. This statement summarizes a problem or potential system and requests a study to determine if the development of a system to satisfy these needs is economically, technically, and operationally feasible. If the Requirement Statement is approved by management (of the user's organization), a letter of authorization is forwarded to Information Systems. However, should management wish to alter or modify the Requirement Statement in any way, they can do so. The option is also available at this point to terminate the project.

II. General Problem Definition and Development Plan Preparation (Figure 2). A Feasibility Study and Development Plan is the result of this step. Included among the items contained in the Development Plan are such things as a problem statement, a statement of assumptions and constraints, gross estimates of development costs and manpower requirements, a tentative completion date, and a statement of the benefits (tangible and intangible). This document is submitted to the user for approval. A letter of authorization is sent if approved; if not approved, new guidance may be offered, or the project may be terminated.

III. Systems Analysis (Figure 3). The document resulting from systems analysis is the Functional Specifications. Included in this document are a revised problem statement, a layout of each type of input and output, a preliminary test plan, and a preliminary implementation plan. This document must also be approved by the user.

IV. System Design (Figure 4). The output of this step is the System Specifications. Among the items included in this document are a system resume, a system flowchart, record summaries, input and output summaries, and form designs. System Specifications are subjected to a technical review to assure that the approach adopted is as efficient and technically sound as possible. Following the technical review, the System Specifications are submitted to the user for approval.

V. Preparation of Program Specifications (Figure 5). Detail specifications are prepared for every program specified in the system design. These documents are designed to enable a programmer to code the program with very little additional information. As they are completed, Program Specifications are forwarded to the user to obtain his approval.

VI. Programming and Implementation (Figure 6). This phase includes the preparation of program documentation, operations documentation, and user documentation. Also during this phase the system test plan and conversion plan (if applicable) are executed. Another element of significance is the preparation of briefing materials which will assist in user training and orientation. When all of these activities have been successfully concluded, the system can become operational.

VII. System Performance Evaluation (Figure 7). Depending upon the system, an evaluation of the system performance should be conducted sometime between six and twelve months after implementation. The evaluation report which is prepared should include:

A. A comparison of the planned versus the actual performance;
B. an evaluation of the degree to which the objectives are being realized;
C. a comparison of planned versus actual costs in time, resources and dollars;
D. suggested improvements for future consideration.

Summary

While this procedure does not provide a means for tracking progress within a phase, it does give each phase a definite beginning and ending point. It insures coordination and management involvement. It also keeps decisions current and on record, and prevents delegation of decision making to programmers. Finally, it helps maintain good relations with customers. The latter is evidenced by the fact that some of the same people, who several years ago were our biggest critics, are now our biggest boosters.

The following section will explain the computer-assisted technique for tracking or controlling systems development.

PROJECT CONTROL SYSTEM (PCS)

Information Systems decided to use the IBM Project Control System (2) in the development of the Federally Insured Student Loan System. The purpose in using PCS was to determine its value as a tool in planning and controlling the development of large computer-based systems. It was the first time this kind of tool was used in a major project. Information Systems uses IBM's Project Control System as a PERT system. Most people are aware of the PERT background. But for those who are unfamiliar, PERT stands for Program Evaluation and Review Technique. It was developed in the late 1950's and initially designed as a reporting technique to evaluate and monitor progress in the development of the Polaris missile system. The Polaris was the first missile to be launched from a submarine underwater. Other similar systems for planning and controlling projects have been developed such as Critical Path Method (CPM), Network Analysis and Precedence Network. Differences between these systems have all but disappeared; indeed PCS distinguishes only between PERT/CPM and Precedence Networks.

Network Concepts

Figure 8, entitled NETWORK SHAPES, better illustrates this distinction. First, a definition is in order - work item. A work item is any distinct unit of work that must be performed during the course of a project. In a precedence network, work items are represented by nodes; in a PERT/CPM network, work items are represented by lines that connect the circles or nodes. Work items are commonly referred to as activities. Using this distinction, the networks represented are PERT or CPM type networks. That is, each activity is represented by a line identified by a job number. In this instance the term job was used because of its short length. Work item or activity could have been just as easily used. In the upper network (a network must be constructed for each project) job or activity A is represented by the line between nodes 1 and 2; job H by the line between

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Project Management Procedures

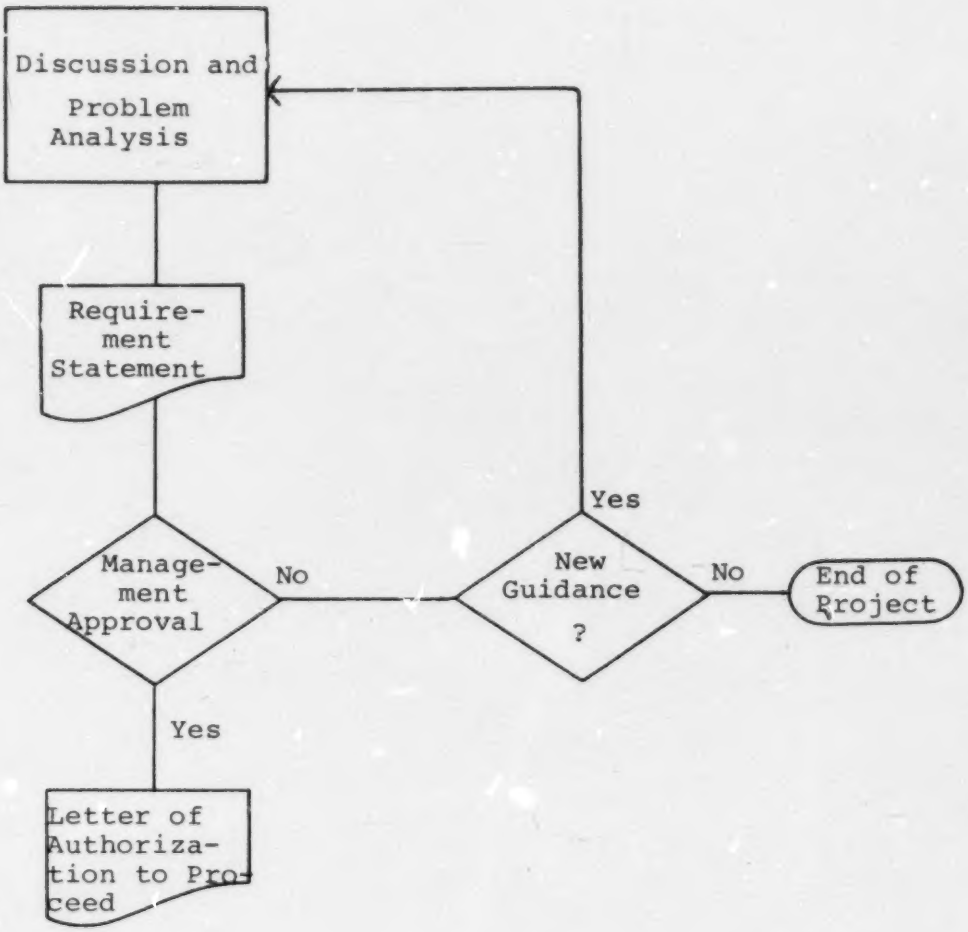

FIGURE 1

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Project Management Procedures

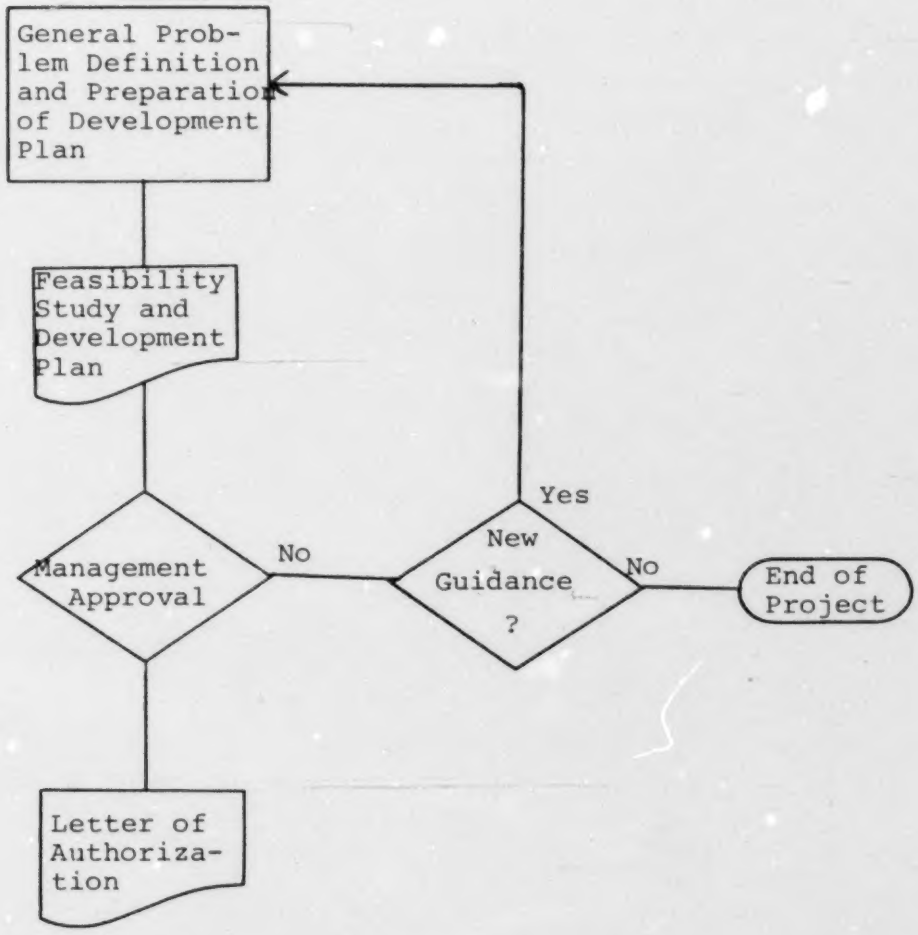

FIGURE 2

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Project Management Procedures

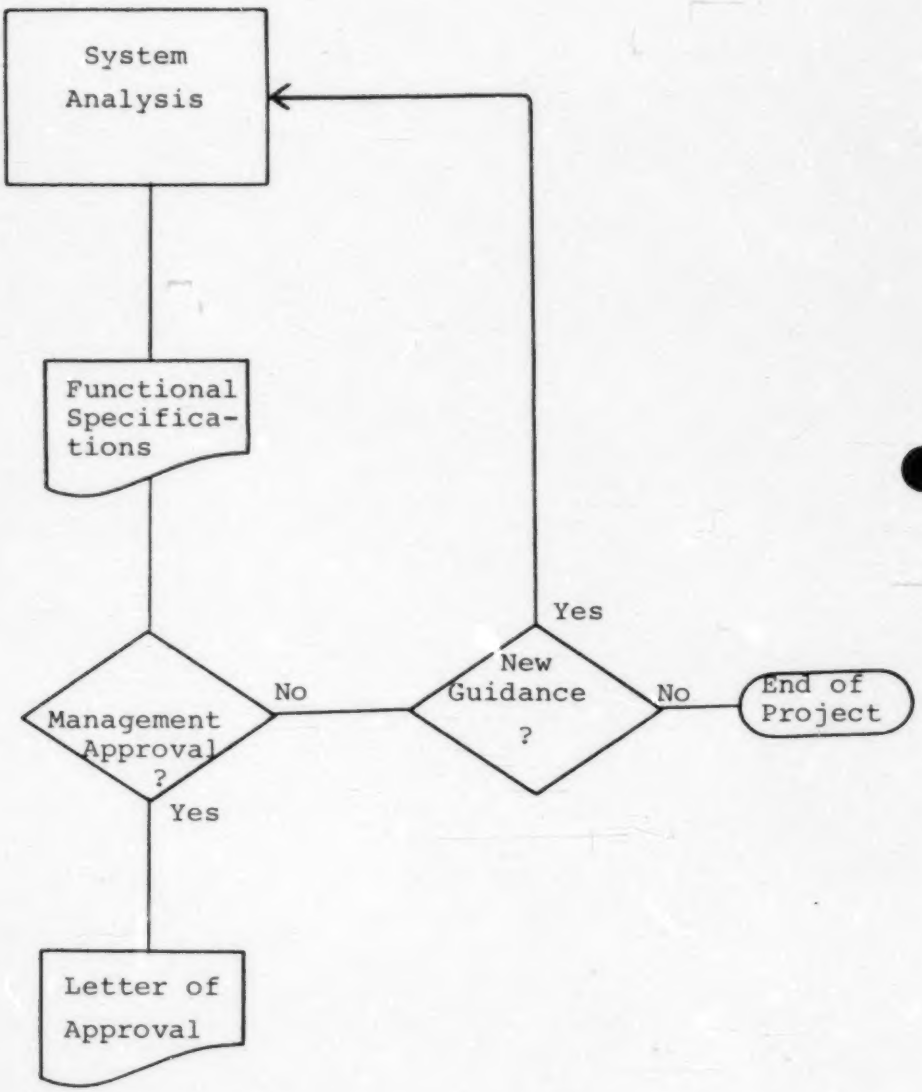

FIGURE 3

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Project Management Procedures

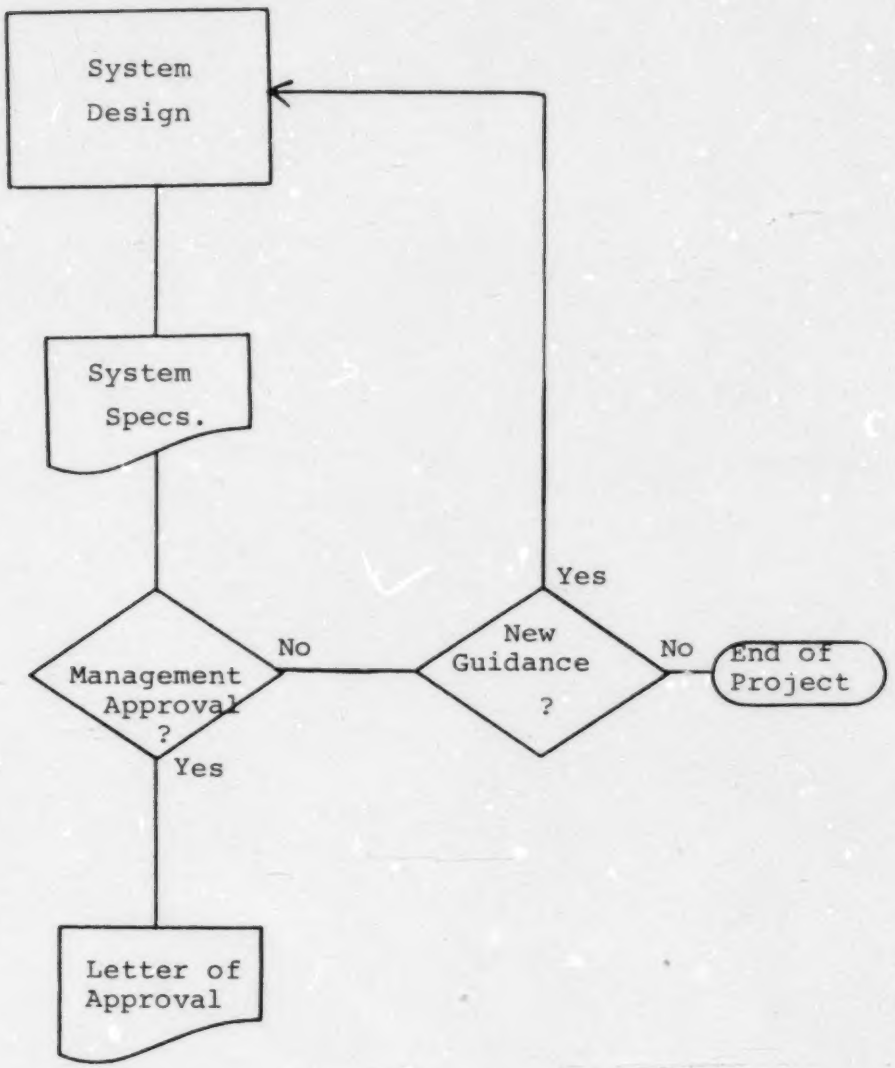

FIGURE 4

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Project Management Procedures

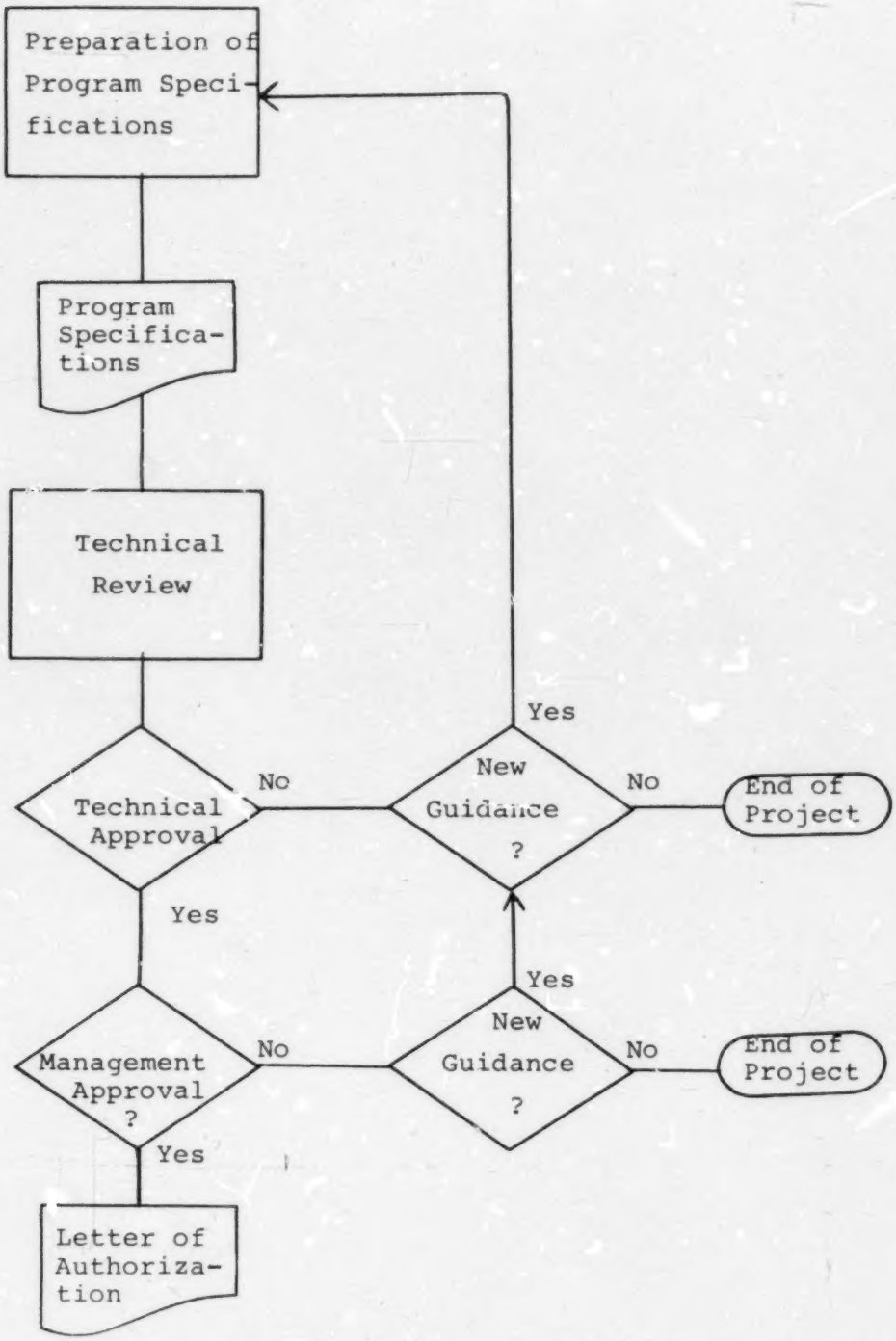

FIGURE 5

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Project Management Procedures

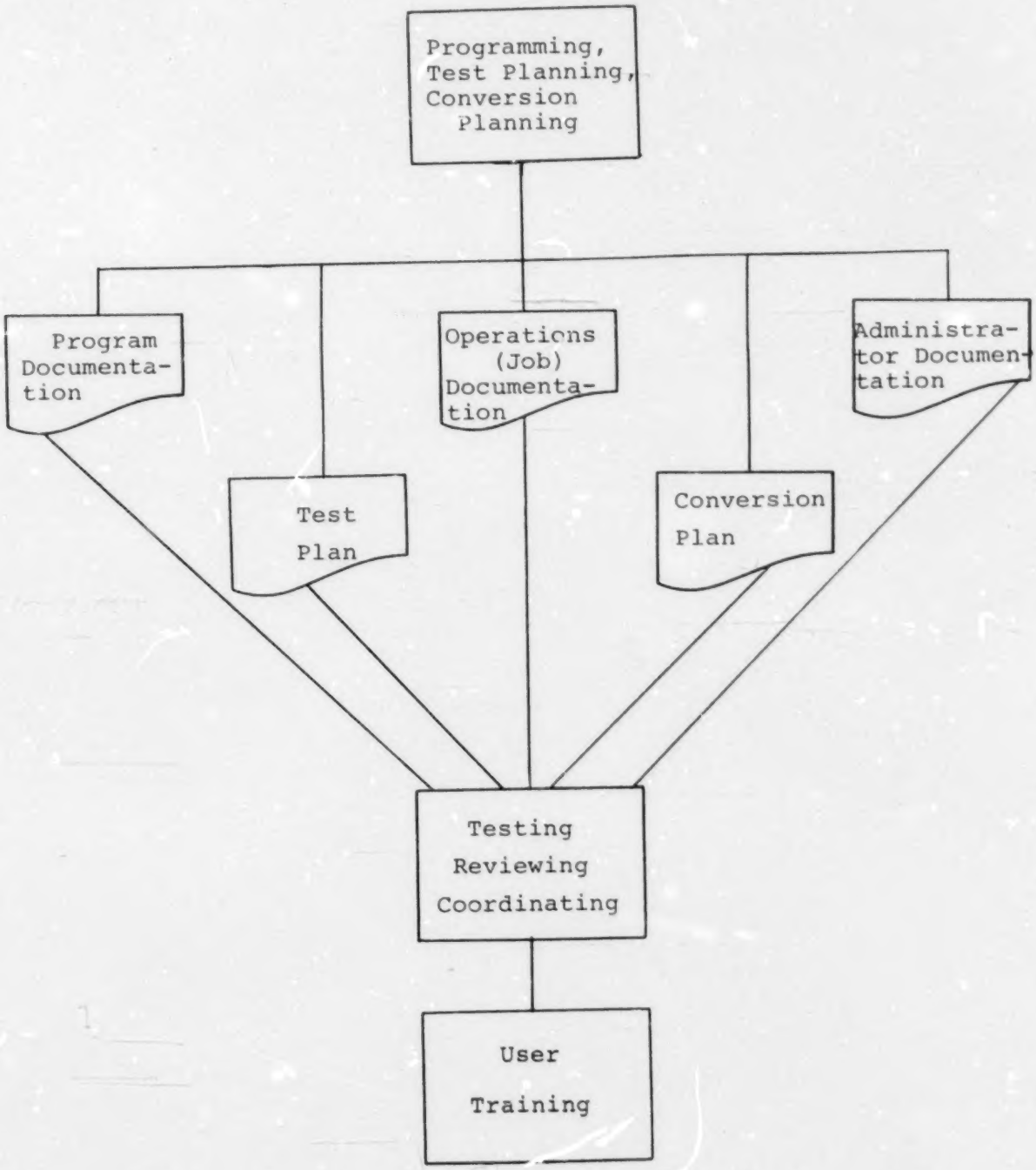

FIGURE 6
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Project Management Procedures

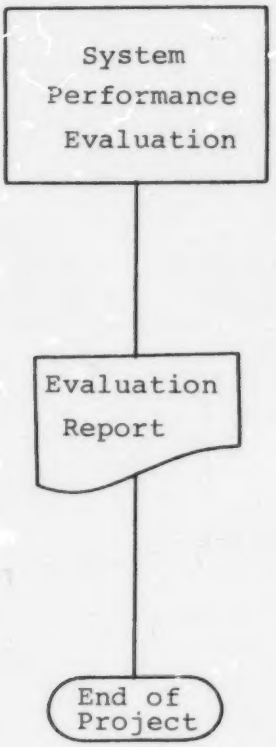
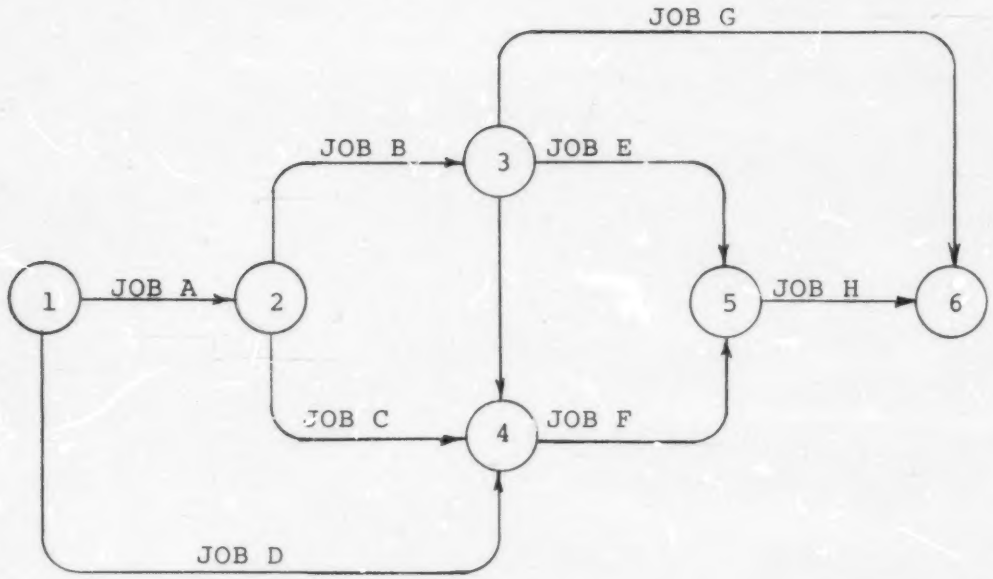


FIGURE 7

NETWORK SHAPES



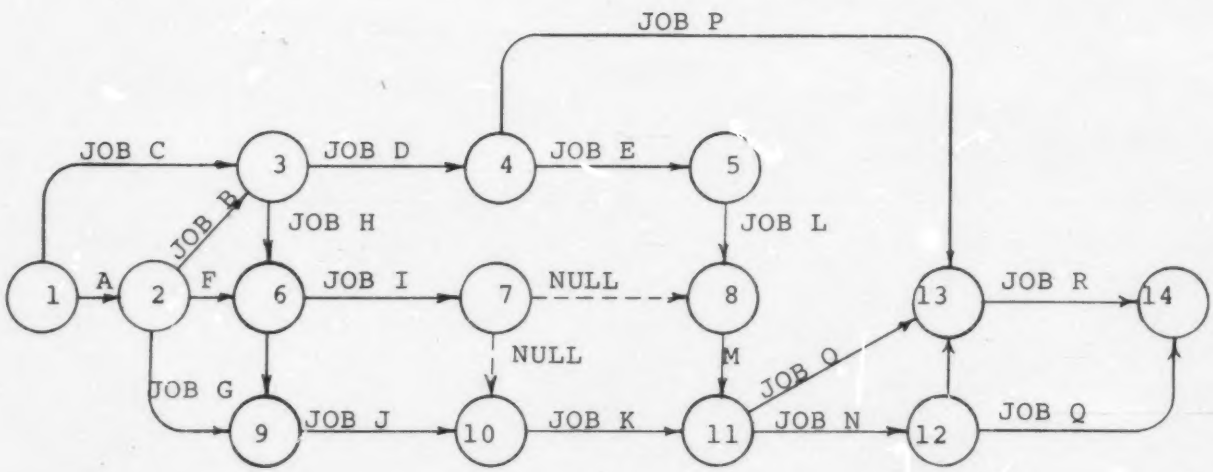


FIGURE 8

5 and 6. The lower network is constructed in the same manner but with more activities. The Federally Insured Student Loan network was constructed in the same manner, except that here were ninety-eight activities initially. In PCS or any other system you have to construct the network by hand. The network drawing for FISL encompasses a rather large sheet of paper, about one foot wide by five feet long. As a matter of fact, in order to construct the network, each activity in the network was identified and written on the back side of punched cards. Then the cards were laid out on the conference table, inter-relationships established between activities and each end of each card numbered. Therefore, the first activity was numbered 1, 2, the second 2, 3, etc. This is a slight oversimplification, but not far from the truth. PCS output reports show that actual activity identification is a four-character alphameric number.

The original FISL network was made up of 98 activities. Subsequent modifications have increased the number of activities to the present one hundred fifteen (115).

PCS Concepts

PCS is a computer system that calculates a project schedule and then allows that project schedule to be updated and maintained as conditions in the project change. It is an extremely flexible system in that almost any element in the network can be modified or changed. It uses the concept of defaults so that unnecessary data need not be entered. Even the structure of the network itself can be modified. The flexibility of the system is further emphasized by the number of different output reports (14) that can be generated. There are also a generous number of report sequences offered.

In the FISL project, only five of the available reports are used. These are the ones that have been most useful. Just remember that the system is capable of producing many other report types. Weekly update time, that is CPU clock time, averages between seven and eight minutes on the Knott Data Center 360/40. This is a modest expenditure for this very valuable tool.

The two primary users in the FISL system receive copies of the weekly PCS reports. One of the most important characteristics of PCS is that it enables the user to clearly see significant inter-relationships between activities that must be performed on the project.

There are nine major properties associated with a work item. These are:

1. description
2. time frame
3. work dates
4. duration
5. percent complete
6. float
7. codes
8. cost
9. milestones

Three of these properties should be addressed before output reports are discussed. The first of these is the concept of duration. Duration is the length of time needed to complete the work item. It may be expressed

initially in terms of hours or days. If expressed in hours, as was done in FISL, PCS converts hours to eight-hour days. This conversion must be taken into account when constructing the network. It should be emphasized that the PCS network will be only as good as the estimated durations for each work item. One further point should be remembered. When estimating project durations, the number of resources to be applied should be considered. If, for example, a work item entitled Programming - Phase 1 is to take 1000 manhours, the number of programmers expected to be used on this activity will determine duration. If five programmers are to be used, then dividing 1,000 by 5 equals 200. Duration then would be 200 hours, rather than 1,000.

The second property of a work item or activity is float. Float can be described as the number of days between the early and late start or early and late completion of an activity. It is sometimes referred to as slack time. Float is non-critical time or extra time.

The third property which merits some explanation is milestone. A milestone is the start or completion of a particular work item which is of major importance to the project. Start or completion of an activity is sometimes called an event.

Two other notions should be briefly mentioned. The first of these is the notion of critical path. The critical path is the most time-consuming path of activities from the beginning to the end of the network. Any delay in the start or completion of a critical activity will delay completion of the project. The second notion is that of a calendar. It is necessary to recognize non-working days, whether these are holidays or any other specified nonwork day. These are recognized in the network scheduling process by establishing a project calendar. Indeed, if a schedule is to be realistic, non-work days must be recognized.

PCS System Inputs and Outputs

Sample inputs and outputs from PCS are available from the author.

PCS Summary

Project Control System/360 is one of the diminishing number of free IBM software products. It has been designed to operate as a DOS background program with a minimal set of operational and job control language requirements. The minimum configuration required is a 32K IBM 360 (PCS, itself, requires 25,448 bytes of core memory), two 2311 disk drives (or 1 if SYSRES is on 2314 or other), console typewriter, card reader, punch and printer. The IBM/PCS/360 manual number is #GH20-0376-3 and the program number is 360A-CP-06X. It is available on 7 or 9 track tape, 800 or 1600 (9 track only) B.P.I., or on a 1316 disk pack.

PCS is a versatile, flexible tool in planning and controlling large computer-based systems development. It enhances the planning function by forcing recognition of all activities that have to be accomplished and their interrelationships. It facilitates control of the project by providing up to the minute information on project status.

The next section describes the application of the two techniques, project management procedure and project control system, to the development of a large computer-based system.

FEDERALLY INSURED STUDENT LOAN SYSTEM

The Florida Loan Program

The Florida Insured Student Loan System, as it is known in Information Systems, is a program in which students at post-secondary educational institutions in Florida can borrow money from the Florida Department of Education (DOE). The DOE is an approved lender in accordance with federal statutes which enables it to participate in the Federally Insured Student Loan Program. The Florida Legislature has, in effect, placed the DOE in the installment loan business. Applicants for loans from the DOE must comply with the restrictions placed upon them by both federal law and Florida statutes. In general, the Florida statutes closely follow the regulations established for the federal program.

History

This program was first proposed to the Florida Legislature in October 1971. In December 1971, during a special session of the Legislature, it was decided to put the question to the people of Florida on the presidential primary ballot in March 1972. In the resulting vote the proposal was approved by a 65% to 35% margin. During the regular legislative session in the summer of 1972, the program was approved and funding was authorized by the sale of bonds up to forty million dollars. The DOE was approved as a lender by USOE in November 1972. The first bonds were sold ($8,000,000) in February 1973. Additional sales of bonds are scheduled for each of the next three years (1974-76). As of April 1, 1973, approximately 750 loans had been made by the DOE totaling about $1,000,000.

Why Not Banks?

Why are banks not used as in other states? This is usually the first question asked, and the answer is that banks are participating in the program. Banks in Florida are annually lending about $20,000,000 however, this is about the maximum that can be expected. One reason for this is that banks are not anxious to become involved in the program because of the long-term loans that bear a relatively low interest rate. Banks, of course, are primarily interested in short-term loans which yield a high return. Another contributing factor is the fact that, because it is a federal program, there is a requirement for considerable reporting to the federal government. Many conservative banks are reluctant to participate because they fear that with reporting comes control.

The primary reason why the legislature chose to have the State become a lender was because of a survey that was conducted in 1970 which revealed that there was a shortage in Florida of 39.5 million dollars for financing educational aid. The legislature was convinced that the only way to overcome this shortage was to make the DOE a lender and provide the funds through the sale of bonds. Since the federal government was insuring the loans then, theoretically, there was no way that the state could lose money, and at the same time the state would be performing a considerable service to students at Florida educational institutions. This was an investment in human resources,and it was the first instance that the State of Florida had ever sold bonds to finance anything other than capital outlay projects.

An indication of the high regard held for the Florida Loan Program is apparent from the results of the first sale of bonds. The Scholarships and Loans Section had anticipated a percentage rate for retiring the bonds of 5.5%, and had figured that they could manage at 5.75%. When the bids were opened, the successful bid was 4.6%. Of the nine bids, only one exceeded 4.75%.

Computer System Development

After the legislature had determined that the Department would become a lender, a search was made nationwide for a computer-based system that could be acquired and easily adapted to the Department's needs. Of all the systems seen, the system being developed by Wachovia Services, Inc., of Winston-Salem, North Carolina, was determined to be the most suitable. An agreement was reached whereby the Department would purchase the System Specifications and Program Specifications from Wachovia Services for $15,000. The System Specifications which were acquired were modified by the Information Systems staff in order to tailor them more closely to the needs of the Department.

It was determined that the proper course of action was to develop our own System Specifications from those which had been acquired. This was done and, in accordance with our project management procedure, the specifications were submitted to the users which, in this case, were two: the Scholarships and Loans Section and the DOE Comptroller. Following approval of the Systems Specifications, the Program Specifications were prepared and approved by the users.

As designed, the system required about sixty computer programs. Development of this system represents a projected twenty-seven man months of effort, about 70% (19 man months) of which will be expended for programming. The programming effort was initiated in late January 1973, and the projected completion date is late in May.

Our Project Management Procedure, together with PERT, has proved to be of immeasurable assistance in the development of this system. Some of the advantages which they provided were:

1. All of the benefits to be gained through an orderly, systematic Project Management Procedure were realized. The fact that the needs of two different user organizations had to be satisfied was unique with this system. Many of the problems which could arise under such circumstances were avoided because of our adherence to this procedure.
2. PERT forced us to identify all of the activities which were required to complete each phase of development.
3. Having defined the activities and their duration, we then had a schedule, thanks to PCS.
4. PERT provided a vehicle which enabled us to more effectively communicate progress to our users.
5. It also provided in-house information as to the status of the project.
6. PERT gave us something more than intuition on which to base decisions.

CONCLUSIONS AND SUMMARY

Successful project management can be achieved by means of well-defined procedures coupled with computer-assisted tools such as PERT/CPM, represented by the IBM Project Control System/360. These techniques significantly contribute to achievement of the two primary purposes of project management:

1. completion of the project within the schedule, and
2. control of the cost of the project.

Information Systems of the Florida Department of Education has successfully used these techniques in the development of large computer-based systems. Beyond the achievement of primary purposes, other benefits have resulted from their use. They are: (not necessarily in order of importance)

1. Bridging the user communication gap by means of user participation throughout all phases of systems development and implementation.
2. More effective planning in terms of activities to be accomplished and their interrelationships.
3. The ability to more effectively monitor and control progress of projects.
4. The great benefit of better user and upper management relations by meeting commitments expeditiously and efficiently.
5. A much better product (system) because of better planning and monitoring.
6. Improved future project planning and control because of better planning and control presently.

Good project management procedures and a good project control system supported by the computer have made a significant contribution to planning and controlling computer-based systems development in the Florida Department of Education. As has been mentioned, these techniques are not foolproof; they do not represent a panacea. There may still be overruns, but they will be fewer and to a lesser degree. Therefore, we highly recommend these techniques.

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